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ABSTRACT

This paper is a report of a pilot project in which a microcomputer was placed in a sixth grade classroom for eight weeks for the purpose of developing logical thinking skills. Students were first given instruction on how to program the APPLE II microcomputer to draw color graphics designs; they were then given similar problems to solve using the commands they had learned. Sample programs are included, as well as student responses to a questionnaire. Responses are highly positive. (Author/JEG)

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MICROCOMPUTERS 'GOTO' SCHOOL

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INTRODUCTION

Recent advances in microelectronics have created a new tool for education - the microcomputer. An astonishing amount of computer power has been packed into a small unit that is portable, reliable, easy to use, and relatively inexpensive. It would be no more expensive today to have a microcomputer in the classroom than to have a movie projector or video tape recorder.

Microcomputers can be used in the classroom for: instructional activities that we associate with CAI (Computer Assisted Instruction) or CMI (Computer Managed Instruction); enrichment activities that we associate with simulations and games; making numerical calculations for the purpose of solving mathematical problems; teaching students how to program - primarily in the BASIC language; and individual exploration of original problem-solving.

This paper is focused on the latter activity. It is a report of a pilot project in which a microcomputer was placed in a sixth grade classroom for 8 weeks for the purpose of developing logical thinking skills. The students were given instruction on how to program the APPLE II microcomputer to draw color graphics designs. They were then given similar problems to solve using the commands they had learned.

AN APPLE FOR THE TEACHER

In the Spring of 1978, I contacted Gordon Kunaschk, a sixth grade teacher at Bose Elementary School in Kenosha, Wisconsin. He was receptive to the idea of giving up two hours a week of class time for eight weeks to let me teach his sixth graders how to program a microcomputer. If nothing else, it would be a lesson in computer literacy. Gordie had never programmed a computer before, but he was willing to learn along with the kids if I was willing to provide a computer and the necessary instruction.

The Center For The Application of Computers at UW-Parkside supported the idea and supplied an APPLE II microcomputer for the project. This was a fortunate choice for us since the APPLE II system is easy to use: it is portable; it has a good keyboard; and most important of all, it has a very simple and natural set of graphics commands that allow the programmer to create pictures on a T.V. screen using 16 different colors. The ideas I wanted to emphasize about computer programming would be considerably enhanced by a graphics display. The basic programming construct of a loop, for example, could be visualized, and every problem to be solved by the students could be represented by a single picture.

GETTING STARTED

My objective for bringing a microcomputer into a sixth grade classroom was to create an environment for active problem-solving. The BASIC programming language statements, enhanced by the graphics of the APPLE II microcomputer, form the logical building blocks. Each lesson consists of a simple program with a short explanation of the new statements, a sample run, and a series of simple program changes for the student to do. These activities allow the student to discover how the statements in the program affect its outcome. Also, problems are posed that require the student to combine statements in sequential order to solve a problem. As a result of working on these questions, the student gets a working understanding of practical problem-solving skills such as:

1. Understand the problem, its givens and goals.
2. Make conjectures and probe the problem by trial and error.
3. Decide on a set of possible methods of attack.
4. Evaluate each possible approach for its correctness.
5. Reflect on successful solutions and generalize.

Each of the following exercises was designed to provide practice for these skills. They are samples taken from a larger collection and are not contiguous lessons.

LESSON #1

Key Words: GR, COLOR, PLOT

LIST	EXPLANATION
10 GR	The computer is put in GRaphics mode.
20 COLOR=9	The COLOR is set to orange. There are 16 different colors to choose from.
30 PLOT 10,15	The position 10 over, 15 down from the upper left hand corner is plotted.
100 END	

RUN

YOUR TURN (RUN the program after each change)

1. Change line 20 to .....20 COLOR=3
2. Change line 30 to .....30 PLOT 5,7
3. Add line 50.....50 PLOT 5,5
4. Add line 40.....40 COLOR=6
5. Delete line 40.....40
6. Add a point that connects 5,7 with 5,5 ...60 PLOT ?,?
7. Add line 30.....30 PLOT 39,39
8. Add line 40.....40 PLOT 40,40
9. Delete line 40.....40
10. Write a program that will display the first letter of your first name in graphics.

LESSON #5

Key Words: FOR-NEXT

LIST	EXPLANATION
10 GR	
20 FOR I=0 TO 15	Begin a loop with I=0 and and increase I by one each time until I=15.
30 COLOR=I	The color changes with each pass through the loop.
40 PLOT I,15	The position to be plotted changes with each pass.
50 NEXT I	End of the loop. Go back to statement 20 if I is less than 15. Otherwise go to line 60.
100 END	

RUN

YOUR TURN (RUN the program after each change.)

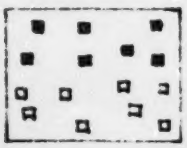
1. Change line 40 to..... 40 PLOT I,10
2. Change line 40 to .....40 PLOT 20,I
3. Change line 20 to .....20 FOR I=0 TO 39
4. Change line 40 to.....40 PLOT I,I
5. Add line 45.....45 PLOT 39-I,I
6. Change the program to draw + in graphics.

LESSON #10

Key Words: RND, IF-THEN

LIST	EXPLANATION
10 GR	
20 COLOR=9	
30 X=RND(40)	A random number is chosen from the numbers 0 to 39 and put in X.
40 Y=RND(40)	Another random number in chosen and placed in Y.
50 IF Y>20 THEN COLOR=3	If Y is larger than 20 then change the color to blue(3).
60 PLOT X,Y	
70 GOTO 20	Go to line 20 and repeat.
100 END	

RUN



YOUR TURN (RUN the program after each change.)

1. Change 50 to .....50 IF Y > 10 THEN COLOR=3
2. Change 70 to .....70 GOTO 30
3. Change 70 to .....70 GOTO 20
4. Change 50 to .....50 IF X > 20 THEN COLOR = 3
5. Add 55 .....55 IF Y > 20 THEN COLOR = 13
6. Delete 55 55
7. Change 50 .....50 IF X + Y > 40 THEN COLOR=3
8. Adjust the program to plot 4 different colors in the four different corners of the screen.

TELL & RUN

In addition to the lessons, the students were given short problems to solve. They were asked to predict the output of a given program before they observed it run on the TV screen. This gave the students a chance to test their ability to reason sequentially through the statements of a program. A few examples are given below.

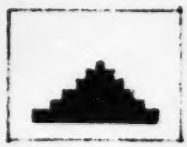
#1

```
10 GR
20 FOR I=0 TO 10
30 COLOR=9
40 PLOT 2,I
50 NEXT I
60 END
```

#2

```
10 GR
20 FOR I=10 TO 20
30 COLOR=I
40 HLIN 0,39 AT I
50 NEXT I
60 END
```

Other activities reversed the process and presented a picture and asked the student to write a program that would produce the same result. Here are a few examples.



COMPUTER AS A CREATIVE TOOL

The APPLE II microcomputer was left in the classroom during the week to give the class time to experiment. Students signed up in pairs to work on the exercises together. The original purpose for doubling up was to provide more computer time for the class each week. But it turned out to be valuable for a completely different reason - cooperation. The students helped each other figure out the effect of each new command. The programming exercises facilitated discussions about the behavior of each new statement. New discoveries were shared with pride and enthusiasm. The computer was the focus and facilitator for cooperative problem-solving.

STUDENT REACTIONS

After eight weeks, the students were asked to respond to the following questionnaire. A scale of 1 to 5 (1-strongly disagree, 5-strongly agree) was used and the responses from the 6th grade class of 14 boys and 10 girls were recorded.

COMPUTER QUESTIONNAIRE

1 - Strongly disagree 5 - Strongly agree	BOYS	GIRLS
1. Computers will improve education.	4.4	4.6
2. Computers make many mistakes.	1.3	1.6
3. Computers treat people like numbers.	2.3	2.7
4. A computer is a tool like a hammer.	2.4	2.2
5. Learning to program a computer is easy.	3.7	3.6
6. My mother could learn to program.	3.3	4.4
7. My father could learn to program.	3.6	4.2
8. I'd rather program a computer than watch T.V.	4.6	4.1
9. I like to work in pairs on the problems.	2.6	3.9
10. Color graphics makes programming fun.	4.9	4.9
11. I'm not afraid of computers.	4.6	5.0
12 I would like to have a computer at home.	4.8	4.8

REFLECTIONS

Only a small sample of the exercises done by the students are given in this paper. An entire collection of problems were prepared for the 6th grade class to be used on the APPLE II. At the present time, good materials are not readily available. This presents a formidable obstacle to the inexperienced teacher who wants to use computers in the classroom. As more classrooms begin using microcomputers and sharing their work with others, this problem will diminish.

Students in this sixth grade class were very enthusiastic about working with a microcomputer. In contrast, students at a nearby high school who had not been exposed to computers before were generally uninterested in learning how to use them. Perhaps by this time, the older students have other activities that are more relevant. Also, in the sixth grade the survey shows that boys and girls are equally confident and interested in programming the computer. But judging from the entries in an annual computer problem-solving contest held at UW-Parkside, by the 10th grade the boys outnumber the girls 9 to 1. A recent survey in Creative Computing Magazine had a response with a distribution of 95.4% male and 4.2% female.

Programming the microcomputer was considered by the sixth graders to be highly motivating. They would rather spend their recess on it than go outdoors. Students came early to school and would hang around as long as they could after school. A sign-up sheet became a necessity. With practice, some of the students became resident 'experts' able and thrilled to help others - including the teacher. Some of the sixth graders entered our annual computer programming contest.

RESEARCH QUESTIONS

This pilot project suggest a number of possible topics for further investigation and research:

1. If students learn how to program a computer early, will they maintain their enthusiam in later years?
2. If students learn how to program a computer early, will the interest and confidence level of girls, in later years, continue to match that of boys?
3. What factors influence the acceptance of microcomputers in the classroom? Graphics? Games? Programming problems?
4. What is the relationship between logical thinking skills and creative programming skill?

CONCLUSION

Computers have been used in education primarily as a delivery system for subject matter. This role will continue to be developed even further with microcomputers. However, a new application is emerging which is fundamentally different. Instead of the computer programming the student, the student learns how to program the computer. Arthur Luehmann describes it as follows:

> "Computing constitutes a new and fundamental intellectual resource. To use that resource as a mere delivery system for instruction, but not to give a student instruction in how he/she might use the resource, has been the chief failure of the CAI effort. What a loss of opportunity if the skill of computing were to be harnessed for the purpose of turning out masses of students who are unable to use computing."

The computer as an instrument for learning logical thinking and problem-solving skills is only beginning to be understood. However, with the rapid development of low cost microcomputers in the next few years, computers - and hence computer problem-solving techniques - will become a fundamental intellectual resource.